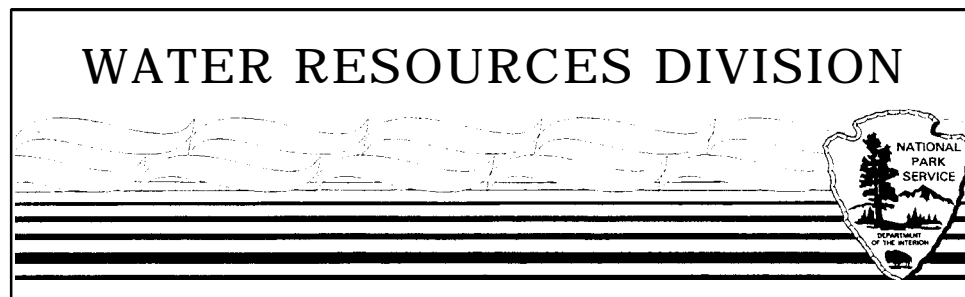


NEW RIVER GORGE NATIONAL RIVER,
GAULEY RIVER NATIONAL RECREATION AREA,
AND BLUESTONE NATIONAL SCENIC RIVER,
WEST VIRGINIA
WATER RESOURCE SCOPING REPORT

New River Gorge National River
and
Water Resources Division
Technical Report NPS/NRWRS/NRTR-96/76



National Park Service - Department of the Interior
Fort Collins - Denver - Washington

The National Park Service Water Resources Division is responsible for providing water resources management policy and guidelines, planning, technical assistance, training, and operational support to units of the National Park System. Program areas include water rights, water resources planning, regulatory guidance and review, hydrology, water quality, watershed management, watershed studies, and aquatic ecology.

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RIVER NATIONAL RECREATION AREA,
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February 1996



United States Department of the Interior
National Park Service

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EXECUTIVE SUMMARY

New River Gorge National River, Gauley River National Recreation Area, and Bluestone National Scenic River represent some of the most significant water resources and water-based recreational activities in the national park system. All three parks are within the Kanawha-New River basin of the Appalachian Plateaus physiographic province. These parks represent a total of 76,761 acres, with only 61% owned by the National Park Service. This multiple ownership/jurisdictional aspect combined with a host of water resource issues have prompted this Water Resources Scoping Report.

The purposes of this Water Resources Scoping Report are: to summarize existing information about the water resources of these parks; and, to determine and briefly evaluate water resource issues in these parks.

Water resources-related issues discussed in this report include:

- bacterial contamination of tributaries due to improper sewage treatment;
- the number of impoundments and their hydrological effects;
- the extent of agricultural and urban runoff;
- the consequences of past coal mining and oil and gas development;
- future upstream silvicultural activities;
- current water quality and the lack of adequate data management;
- non-native trout stocking in tributaries;
- hazardous materials/toxics from spills, abandoned landfills, superfund sites, and military dumps;
- evaluating the effects of continued black fly spraying; and, the potential for future development both inside and beyond park boundaries.

Because of the nature of the issues and the complex nature of both surface and ground water resources, further water resource planning is needed. The development of a comprehensive water resources management plan is recommended. An important element of this plan should be the development of a water quality monitoring plan. This monitoring plan should discuss the rationale behind the selection of monitoring parameters, sampling stations and sampling frequencies, additional data collection, and methodologies for data collection, storage, and analysis.

EXISTING RESOURCE CONDITION

Water is often a significant resource in units of the National Park Service (NPS), either through support of natural systems or providing for visitor use. The NPS seeks to perpetuate surface and ground waters as integral ecosystem components by carefully managing the consumptive use of water and striving to maintain the quality and health of aquatic ecosystems in accordance with all applicable laws and regulations. Water resource inventory and monitoring activities are, therefore, essential activities of park resource management.

This water resources scoping report summarizes existing water resource information and identifies and discusses a number of water resources-related issues and management concerns pertinent to New River Gorge National River and its associated units, the Gauley River National Recreation Area and the Bluestone National Scenic River. It provides information required by the Water Resources Division of the National Park Service to determine if a water resources management plan is needed for these units. Additionally, the summary of water related issues can be incorporated into the park's resources management plan.

LOCATION AND LEGISLATION

Figure 1 shows the location of the three parks relative to the physiographic region and watershed in which they exist. All three parks are located in southern West Virginia.

New River Gorge National River is 53 miles long and encompasses a 62,080-acre river corridor (41,845 NPS-owned acres) from Hinton to the U.S. 19 bridge near Fayetteville. New River Gorge National River was established in 1978 to conserve and interpret the park's resources and preserve this segment of the New River as a free-flowing stream (National Park Service, 1982).

Gauley River National Recreation Area was established in 1988 to preserve the natural resources and recreational activities associated with the lower Gauley River and a portion of its major tributary, the Meadow River. Gauley River National Recreation Area encompasses 10,323 acres (2,145 NPS-owned acres) along 25 miles of the Gauley River and 6 miles of the Meadow River.

Bluestone National Scenic River was also established in 1988 through an amendment to the Wild and Scenic Rivers Act and encompasses a 4,268-acre (3,032 NPS-owned acres) river corridor along 10.5 miles of this stream.

Important facets of congressional legislation relevant to these units include:

- Fish stocking is conducted by the State of West Virginia within park waters.

Gauley River National Recreation Area: "The secretary shall permit the State of West Virginia to undertake or continue fish stocking activities carried out by the State in consultation with the secretary on waters within the boundaries of the recreational area..." [Public Law (P.L.) 100-534, Title II, Sec. 202bJ.

Bluestone National Scenic River: "Nothing in this act shall affect or impair the management by the State of West Virginia or other wildlife activities in the Bluestone

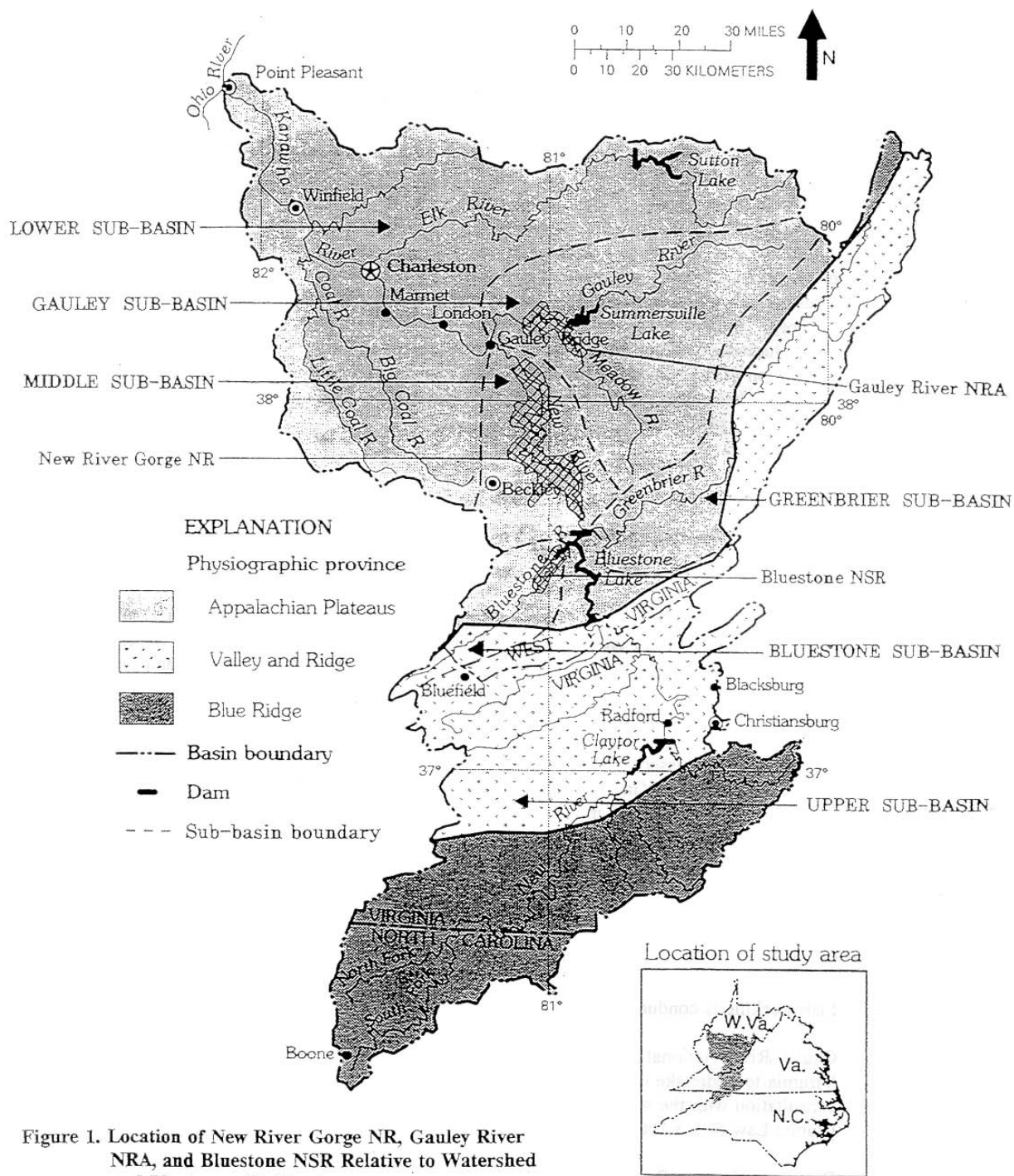


Figure 1. Location of New River Gorge NR, Gauley River NRA, and Bluestone NSR Relative to Watershed and Physiographic Province

Public Hunting and Fishing Area to the extent permitted in the lease agreement..." (P.L. 100-534, Title III, Sec. 301).

New River Gorge National River: There is no reference to fish stocking, only a general provision that the secretary "...may permit hunting and fishing...in accordance with applicable Federal and State laws..." (P.L. 95-625, Title XI, Sec. 1106).

- The state regulates commercial watercraft services (rafting).
- Hunting and fishing are allowed under state guidelines.

The state conducts a pesticide spraying program on the New River to control black fly populations and the National Park Service conducts a monitoring program on its effects. This legislation expired in 1995.

The U.S. Army Corps of Engineers was directed to take technically feasible measures to prohibit the release of drift and debris to the New River below Bluestone Dam.

The U.S. Army Corps of Engineers was directed to include white water recreation as a project purpose for the Summersville Dam project (Gauley River) and the Bluestone Dam project (New River).

WATERSHEDS AND HYDROGRAPHY

Figure 1 shows the layout of the three units relative to their contributing watersheds. The Kanawha River is the master stream formed by the confluence of the New and Gauley rivers and drains to the Ohio River. For the purpose of orienting the issues relative to each unit, the watershed has been broken down into six sub-basins: the lower, middle, and upper sub-basins along the mainstem; and the Gauley, Greenbrier and Bluestone sub-basins which are major tributary watersheds.

The Kanawha-New River Basin encompasses 12,233 and extends into West Virginia (8,424 mi²), Virginia (3,044 mi²), and North Carolina (765 mi²). In 1990, approximately 870,000 people lived in the basin. In that year, 25% of the population resided in Charleston, West Virginia. Major industries include chemical manufacturing (mostly in the lower sub-basin), coal mining, forestry, agriculture, and recreation. Three physiographic provinces are included in the basin: the Appalachian Plateaus, the Valley and Ridge, and the Blue Ridge. Steep slopes (greater than 20%) are characteristic throughout the basin, with flat areas limited to valley bottoms and ridge tops. Average annual precipitation is 43.5 inches. Average annual runoff is 20.5 inches, with approximately 55% of that in ground water discharge (U.S. Geological Survey, 1994).

The New River originates at an elevation of 3,800 feet in the Blue Ridge Mountains of North Carolina and flows generally north. It flows 250 miles before it joins the Gauley to form the Kanawha, and has an average rate of fall of 13 feet per mile. The mean discharge for the last ten years, measured at Thurmond, West Virginia, (midpoint of New River Gorge National River) is 8,798 cubic feet per second (cfs). The maximum discharge during this period was 89,400 cfs and the minimum was 808 cfs. There are 34 impoundments above the lower sub-basin. Eighteen of these impoundments are located in the Bluestone sub-basin (West Virginia Department

of Natural Resources, 1983). Pre-dam river flows exhibited a high degree of variability that have been dampened significantly by management of upstream reservoirs (Flug, 1987).

The Gauley River flows west-southwest, is 107 miles long, and occupies a drainage basin of approximately 1,422 square miles. Flow has been regulated by the Summersville Dam since 1965. Mean discharge below the dam is 2,084 cfs for the 21 year period of record (1974 to the present). The maximum discharge was recorded on August 24, 1989 at 18,200 cfs and the minimum was recorded on February 16th and 17th, 1967 at 1.9 cfs. The Gauley River drops an average of 26 feet per mile through a gorge 500 feet deep, and is noted for its technically demanding white water including nine class V or above rapids. The Meadow River is a major tributary to the Gauley and is under National Park Service jurisdiction for a portion of its length. The average gradient of the Meadow River is 71 feet per mile and it is considered runnable by only a few very experienced kayakers. The Meadow River, because of limited access and its steep, rugged terrain, appears to possess some of the best water quality found in the three areas under administration by the National Park Service (National Park Service, 1994a).

The Bluestone River is 77 miles long and confluent with the New River within the backwaters of Bluestone Lake. Despite its length, the Bluestone sub-basin is very linear with no major tributaries. Thus the total drainage area of the sub-basin is only 462 square miles. The Bluestone River has a total fall of 2,060 feet from source to mouth, or nearly 27 feet per mile. The mean discharge for the 41 year period of record is 469 cfs. The maximum recorded discharge of 19,300 cfs occurred on April 5, 1977. The minimum discharge of 7.0 cfs was recorded from September 21st to the 23rd, 1955 (West Virginia Department of Natural Resources, 1983).

HYDROGEOLOGY

Geologists consider the New River to be the second oldest river in the world after the Nile River. It is the only river that cuts through the Appalachian Mountains instead of draining from or around them. The rock types within the basin range from crystalline (igneous and metamorphic) in the Blue Ridge Province to sedimentary in the Appalachian Plateaus and Valley and Ridge Provinces. The Appalachian Basin of the eastern United States experienced sediment accumulation for most of the Paleozoic era, 570 to 225 million years ago. Rocks formed in the basin are typically flat-lying non-marine shales and sandstones interspersed with limestone and coal. The coal bearing rocks of the central Appalachian Mountains accumulated nearly 300 to 250 million years ago during the Pennsylvanian and early Permian periods and are generally low sulfur (less than 1.5%) (U.S. Geological Survey, 1982).

Groundwater occurs primarily in fractures within rocks and pore spaces within unconsolidated sediments and regolith. Of the 1,680 million gallons (Mgal/d) of water withdrawn from the basin in 1990, only 20% was ground water, predominantly from Lower Pennsylvanian aquifers in the Appalachian Plateaus. However, in the Bluestone and Greenbrier sub-basins, ground water usage is twice that of surface water (U.S. Geological Survey, 1983). Regional groundwater flow is toward the major river systems, but recharge and transport have been altered dramatically by coal mining in some areas.

Underground mine tunnels are so pervasive in the area surrounding New River Gorge National River that a karst-like hydrology has formed within many coal beds. Fracturing associated with subsidence has increased the permeability of strata overlying coal mines and drained perched aquifers that once fed springs and associated wetlands. Percolating groundwater can thus enter

mine shafts and be transported rapidly for great distances. Numerous municipalities and private residences have located pumps within abandoned mine shafts to extract water from these artificial aquifers (U.S. Geological Survey, 1994; McColloch, 1986; National Park Service, 1994a).

SOILS

The soil associations within the Kanawha basin are diverse but typically shallow and poorly drained where they are formed on clay rich shales and siltstones, and porous in flood plains or over sandstone. Most soils are on moderate to steep slopes and have a high erosion potential when vegetative cover is removed (U.S. Geological Survey, 1982). Within the New River Gorge National River boundary, soils of moderately deep silty or sandy loams are usually well drained, very stony, and strongly acidic (National Park Service, 1982; Gorman and Espy, 1975).

LAND USE

Land use is influenced by the rugged topography and steep slopes. Consequently, commercial and residential construction tends to concentrate in valley floors which are subject to periodic flooding. Forests are the dominant land cover of the Kanawha River Basin, occupying approximately 71% of the area (Figure 2). Approximately 23% of the basin is used for crops and pasture and 3% is urban. Focusing on the middle and Gauley sub-basins, the forest cover is even higher at 85%, while agricultural land accounts for 7%, urbanized land 3%, and active surface mines 1%. Within the West Virginia portion of the Kanawha River Basin, 32.7 million tons of coal were produced in 1979. In that year, 26.3 million tons were produced from 469 underground mines, and 6.4 million tons from 255 surface mines (U.S. Geological Survey, 1982;1994).

Historically, populations around the New River followed the boom and bust cycles of coal and timber. During the 1970s, the counties containing New River Gorge National River (Summers, Raleigh, and Fayette) increased in population by 19.2% The population forecast for 1980 to 1990 estimated an additional 16.7% growth for these counties (National Park Service, 1984). In reality, the 1990 census showed a loss of 13%. The total population for these three counties is 138,975. The largest city, Beckley, is home to 20,492 people.

HUMAN USE

With the designation of New River Gorge National River, the New River area is experiencing increasing visitation. In 1975, the number of New River Gorge National River users was estimated at 50,000 and in 1982, the estimate grew to 100,000. By 1994, the number of visitors had climbed to over one million. Increasing use is also occurring on the Gauley River (258,747 visitors in 1994) and the Bluestone River (66,089 visitors in 1994) (National Park Service, 1994a).

WATER QUALITY

Water quality in the Kanawha River basin ranges from very good to very poor. According to reports produced by the U.S. Geological Survey (U.S. Geological Survey, 1982), surface water quality and stream flow data are available from 130 locations in the lower, middle, and Gauley sub-basins, and from 149 sites in the Greenbrier and Bluestone sub-basins prior to 1980.

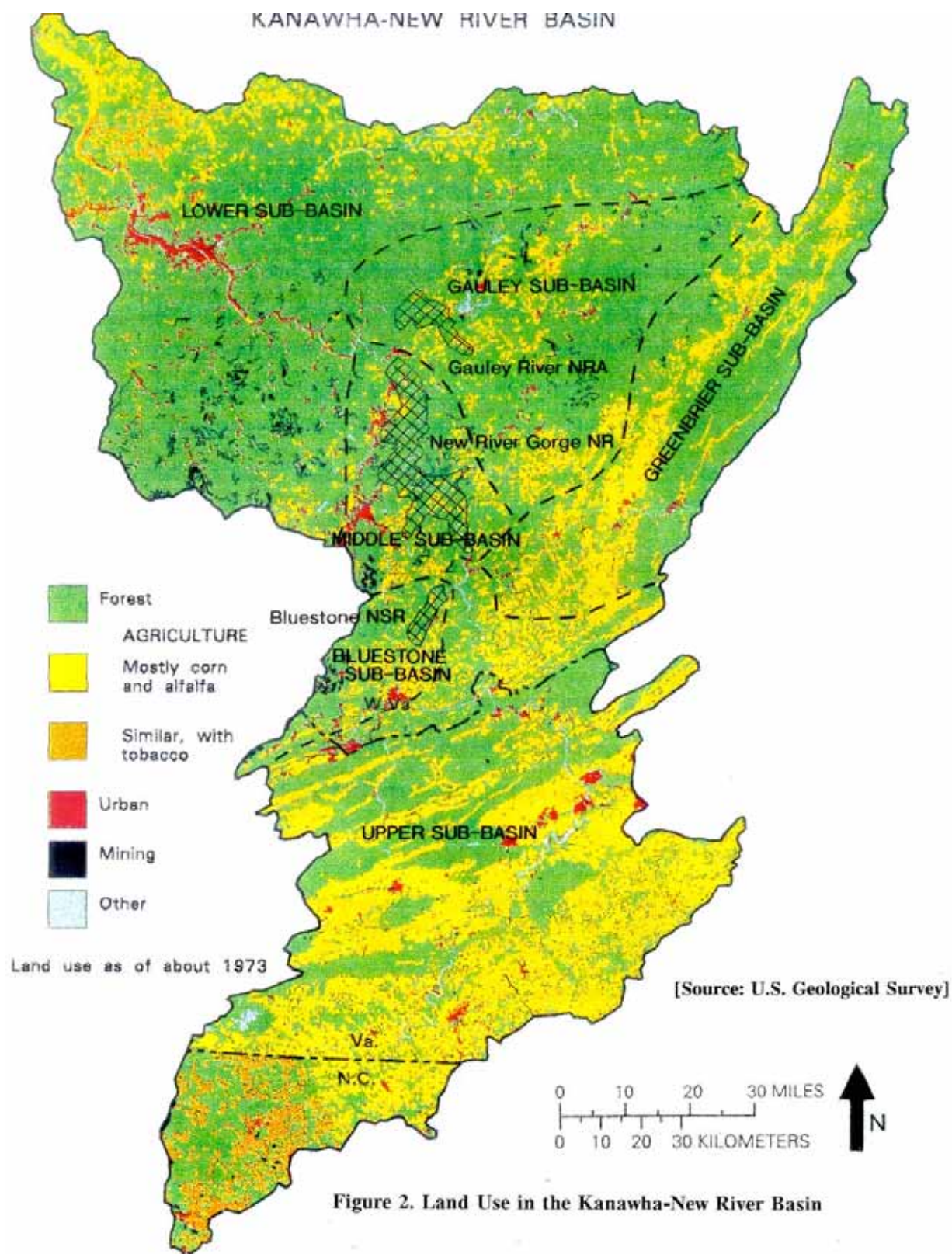


Figure 2. Land Use in the Kanawha-New River Basin

Currently, the National Park Service's Water Resources Division is completing a data inventory and analysis report for New River Gorge National River which should incorporate some of the data from these sites. This report will review all water quality data collected within the three units and for three miles upstream and one mile downstream of the boundaries. The report will also contain data regarding two point source discharges, drinking water intakes, and major surface impoundments. The Kanawha basin has also been included within the U.S. Geological Survey National Ambient Water Quality Assessment Program (NAWQA). The Kanawha study unit is slated for funding in FY96. This study will provide a thorough review of existing water quality data, collect new data intended to identify factors that affect water quality, and will define trends (U.S. Geological Survey, 1994).

According to the West Virginia Water Quality Status Assessment (West Virginia Department of Natural Resources, 1988): "The vast majority of toxic pollutants in West Virginia's waters originates from coal mining discharges, most of which are abandoned...over 2,400 stream miles have been monitored and reflect elevated toxic levels due to mining sources." The report also states that very little data are available on organic toxics (pesticides, etc.) in the state's waters due to the high analysis costs. Toxic contamination from organic compounds and trace elements has resulted in the state of West Virginia warning citizens against eating fish from the lower Kanawha basin (U.S. Geological Survey, 1994). Over half of the 67 tests for phenol conducted in the Bluestone River sub-basin from 1967 to 1972 violated the state criterion for this parameter (West Virginia Department of Natural Resources, 1978).

Mining operations have measurably altered specific conductance and pH to varying degrees in each of the sub-basins. Mining operations increase specific conductance by discharging highly mineralized drainage from underground mine portals, spoil piles, and by direct drainage from coal preparation plants. The pH can be either more acidic (runoff of sulfuric acid from spoil piles) or more alkaline (crushed limestone on interior mine surfaces) depending on the mineral assemblage occurring with the coal and the nature of the discharge. Other parameters that relate directly to mine drainage are sulfate, iron, and manganese, which are consistently higher in association with mining areas (U.S. Geological Survey, 1982).

The specific conductance of surface waters downstream from mining areas was 2 to 10 times greater than unmined upstream areas. The increase in conductance was most pronounced in actively mined areas during periods of high runoff. Analysis of variance showed mean sulfate concentrations were significantly greater ($p=0.05$) in streams draining coal-mined watersheds (58 mg/l) than those draining watersheds without mines (8.7 mg/l). Iron and manganese concentrations were affected in a similar manner (U.S. Geological Survey, 1983).

Suspended sediment concentrations vary widely throughout the sub-basins on temporal and spatial scales depending on shifting land use patterns, geology, and precipitation. Of these three variables, land use has the most affect and mining can have the greatest impact per square mile. Studies in the Kanawha basin demonstrated sediment yields of:

24 tons/mi²/yr for forest lands;

240 tons/mi²/yr for grasslands;

- 12,000 tons/mi²/yr for harvested forest lands; and,
- 27,000 to 66,000 tons/mi²/yr for surface mining and road construction.

Where several of these activities occur simultaneously, suspended sediment concentrations can be as high as 55,900 mg/l. The Gauley sub-basin generally has the lowest suspended sediment concentration (maximum of 361 mg/l) because the headwaters of this drainage are relatively undisturbed (U.S. Geological Survey, 1982).

Elevated fecal bacteria concentrations are also of concern throughout the Kanawha basin mostly as a result of untreated sewage from overloaded and improperly managed sewage treatment plants, faulty septic systems, and direct discharges from streamside residences. Nonpoint source runoff from agricultural operations and storm water routed through Public Service District waste treatment facilities can provide contaminant spikes of logarithmic proportions (West Virginia Department of Natural Resources, 1983).

ECOLOGY

The New River supports a diverse population of game fish which attract many anglers each year. These include walleye (*Stizostedion vitreum*), channel (*Ictalurus punctatus*) and flathead (*Pylodictis olivaris*) catfish, white (*Pomoxis annularis*) and black (*Pomoxis nigromaculatus*) crappie, hybrid striped bass (*Morone saxatilis*) and smallmouth bass (*Micropterus dolomieu*). Additionally, the State of West Virginia Department of Natural Resources stocks non-native rainbow (*Oncorhynchus mykiss*), brown (*Salmo trutta*), and brook (*Salvelinus fontinalis*) trout in tributaries to the New River. The age of the river and its long history have allowed 23 species of plants and animals (seven species of fish) to develop which are endemic to the New River drainage (Stauffer et al., 1995). Kanawha Falls, just below the confluence of the New and Gauley Rivers, once acted as a major barrier to ecological migration from the Mississippi River basin to the New River drainage. Prior to European settlement, 90 native fish species existed below Kanawha Falls, whereas only 50 species existed above the falls. As a result of human introductions, today's species distribution above and below the falls is about equal (Cincotta, 1995).

IMPOUNDMENTS

New River Gorge National River is situated between two impoundments, Bluestone Dam upstream and Hawks Nest Lake downstream. Hawks Nest Dam is 60 feet high and was constructed in 1936. At the dam, the river is diverted into a 4 mile tunnel to pass through power-generating turbines. This leaves an intermittently flowing 5 mile segment known as "the dries." Bluestone dam is 165 feet high and was built as part of a flood control network for the Ohio River valley. It is managed by the U.S. Army Corps of Engineers in a "run of river" fashion (an equal amount of water is let out of the dam as flows into Bluestone Lake). However, base flows are supplemented and peak flows are attenuated so that the true nature of the river system's discharge fluctuations are significantly altered. Much of this alteration results from the hydroelectric generation activity at the non-federal Claytor Dam farther upstream and through efforts to keep lake levels relatively constant within Bluestone Lake. Summersville Dam is located immediately upstream from Gauley River National Recreation Area and is managed by the U.S. Army Corps of Engineers. It has drastically altered the historic flow rates, water temperatures, and ecology in the Gauley River.

STAFFING AND ONGOING PROGRAMS

The resource management staff resides within the Resource Management and Visitor Protection Division and reports to the Superintendent through the Chief Ranger. The staff consists of: a Supervisory Resource Management Specialist (Ken Stephens); a Land Resource Specialist (vacant); a Water Resource Specialist (vacant); two permanent biological technicians (Robert Sullivan and one vacant); two term biological technicians (Lisa Wilson and Kathy Oney); and two temporary biological technicians (John Davis and Brett Marshall). Specific programs related to water resources include a long term ecological monitoring system, water quality monitoring, and small stream biological assessments. The resource staff maintains a comprehensive list of relevant contacts with outside entities categorized by issue.

WATER RESOURCE ISSUES

SEWAGE DISPOSAL

The most pervasive water resource issue at New River Gorge National River is improper treatment and disposal of human sewage. Bacteria contamination is found at various levels in every tributary with higher concentrations exceeding state standards for contact recreation by three orders of magnitude. The sewage detected by bacterial monitoring also elevates nutrient concentrations and biological oxygen demand. Toxics and metals associated with poorly or untreated municipal outfalls, combined with cumulative impacts from other sources, are probably impacting stream biotic communities.

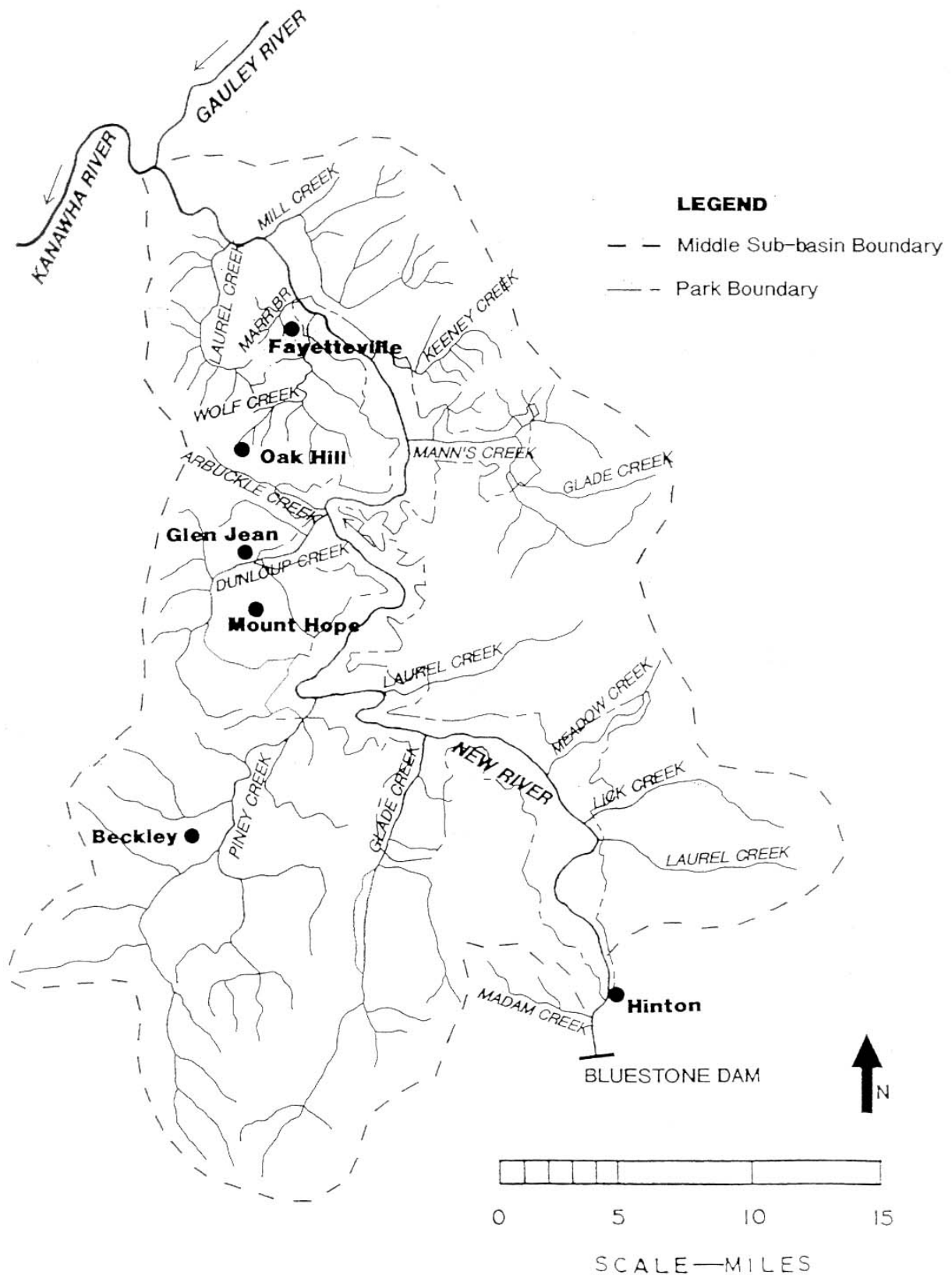
Sewage contamination is a well documented problem. The State of West Virginia Department of Natural Resources in its *New River Basin Plan* commented: "The vast majority of violations were due to fecal coliform bacteria which is associated with domestic sewage" (West Virginia Department of Natural Resources, 1983). The human waste entering the tributaries and main stem of the New River has four modes of input: sewage treatment outfalls; improperly functioning septic systems; "straight pipe" discharges from stream-side residences; and heavy visitor usage in the river corridor where sanitary facilities are lacking. The percentage of waste coming from each source has not been defined and the relative magnitude varies with hydrologic conditions.

National Park Service monitoring conducted in cooperation with the State of West Virginia's Water Resources Division revealed five tributaries with routinely high concentrations of fecal coliform bacteria: Dunloup Creek, Marr Branch, Wolf Creek, Arbuckle Creek, and Piney Creek (Stephens, 1993; Wood, 1990). Other tributaries along the New River with sewage problems include Madam Creek near Hinton, Coal Run near Cunard, and Keeney Creek near Winona (Figure 3).

Dilution and die-off usually keeps bacteria levels below state standards for contact recreation [400 colonies (col)/100 ml for individual samples] in the New River. However, along those stream segments where full mixing from contaminated tributaries or sewage outfalls has not occurred, standards are exceeded. For example, below the former sewage outfall at Hinton, 49 out of 59 samples collected during the summers of 1987 and 1988 exceeded 400 col/100 ml, and nine samples exceeded 20,000 col/100 ml (West Virginia Department of Natural Resources, 1989). Under appropriate hydrologic conditions, bacterial loads from confluent tributaries can also overwhelm the diluting capacity of the river. Bacteria pulses are most pronounced when storm-induced urban runoff overloads sewage treatment plants discharging large volumes of untreated sewage (Hebner, 1991).

Recreational activities such as hiking, swimming, kayaking, rafting, and fishing can place park visitors in contact with waters commonly exceeding primary contact recreation standards (West Virginia Department of Natural Resources, 1989; National Park Service, 1993; Wood, 1990). River access points often coincide with the confluence of polluted tributaries and the New River. Public perception of the National Park Service providing access in areas of documented contamination is viewed as a significant issue by New River Gorge National River management. The park has attempted to post informational signs in problem areas, but they have been torn down. One tort claimed that a victim injured in a fall was infected by tributary waters, ultimately resulting in the victim's death (Stephens, 1993). Marr Branch receives effluent from the town of Fayetteville and on one occasion when the stream was "running black" (prior to a new treatment

Figure 3. Large Tributaries and Municipalities in the Middle Sub-Basin



facility coming on-line), National Park Service monitoring recorded a dissolved oxygen reading of 0.5 mg/l and bacteria counts exceeding 60,000 col/100 ml (Vercolen, 1994).

Water quality monitoring and other surveillance methods provide strong evidence of the source and resultant impact to New River Gorge National River water resources caused by sewage contamination. Law enforcement staff have been and continue to work with the U.S. Attorney's Office on sewage disposal issues. As a result of numerous permit (National Pollution Discharge Elimination System) violations, the state of West Virginia has placed the city of Beckley under administrative order to come into compliance with permit conditions. However, to date the city has not taken action to comply with this order.

Compounding the sewage loads from sewage treatment plants are faulty septic systems and direct discharges. In 1987, only one (Hinton) of the eleven communities along or within the boundary had sewage treatment facilities (National Parks and Conservation Association, 1987). Today, four communities have operating sewage treatment facilities. As mentioned earlier, much of the development has occurred along streams and within flood plains. Septic systems constructed within flood plains back up during high water, and a relatively short pathway exists between leach fields and adjacent streams. Another disposal method use by area residents is a 4 inch PVC pipe to the creek. This practice is so commonly accepted that municipalities sometimes install the straight pipes and maintain them when clogged.

Other potential sources of bacteria include back-country recreational activities, and improper disposal of chemical toilet vaults and sewage sludge. Agricultural activities are not an intensive land use in the middle sub-basin, but upstream contributions greatly increase bacterial loads in the New, Bluestone, and Greenbrier rivers during periods of high rainfall. Farmland nonpoint source pollution is treated in more detail under the "Agricultural and Urban Runoff" section.

IMPOUNDMENTS

The Bluestone and Summersville dams exhibit major alterations in the historic flows of the New and Gauley rivers, respectively, and were established predominantly for flood control. More recently, releases are timed to boost the multi-million dollar rafting industry (Flug, 1987). These bottom-release dams decrease stream temperatures in the tailwaters. The Summersville Dam is the larger impoundment and cooler waters from its depths allow a trout fishery to exist below this dam within Gauley River National Recreation Area. Releases from Summersville Lake are used to augment water quality in the lower section of the Kanawha River near the Chemical Valley at and below Charleston (Steelhammer, 1995). In the Kanawha, pollution suppresses late summer and fall dissolved oxygen concentrations below the state water quality standard. Flow and dissolved oxygen quantities are elevated by releases from Summersville Lake during these times.

The greatest management concern associated with flow regulation may be insuring that riparian habitat remains in good condition, i.e. the flood-scoured rocky and sandy riverbanks that support most of the documented rare species at New River Gorge National River, Gauley River National Recreation Area, and Bluestone National Scenic River (Norris, 1992).

This habitat is created and maintained by seasonal flood waters that erode in some places and deposit in others, and tend to subdue the development of vegetative cover. This natural process was more effective before the attenuation of flood peaks (Norris, 1992). In some areas successional changes have already been documented where former riparian habitat is converting to

stable upland communities (McDonald and Trianosky, 1995). Geomorphic channel alterations may also be taking place, but studies addressing this question, if they exist, were not found.

Proposals for hydropower development have been put forth at both the Summersville and Bluestone facilities. Power generation at Summersville Dam will take advantage of existing release patterns and will not be a major management concern. A license has been issued for preliminary planning, and New River Gorge National River staff is involved in the environmental review of related documentation. At Bluestone Dam, the hydropower proposal has not been finalized, but the U.S. Army Corps of Engineers proposes raising the elevation of Bluestone Lake by a minimum of eleven feet to increase the volume of the power pool behind the dam (U.S. Army Corps of Engineers, 1984).

The proposed increase in maximum Bluestone Lake elevation would flood a portion of the Bluestone National Scenic River, approximately 250 acres. The Water Rights Branch of the National Park Service has concluded that a water rights conflict between the reservoir project and New River Gorge National River does not exist. The legislation creating the national river is consistent with the project purposes. The legislation recognized the purposes of both New River Gorge National River and the Bluestone Dam, and stated that the U.S. Army Corps of Engineers should coordinate and cooperate with the National Park Service in providing water releases from Bluestone Dam.

The Water Rights Branch also concluded that no water rights conflict exists between the project and the Bluestone National Wild and Scenic River. The legislation creating the wild and scenic segment (PL 100-534) recognized the reservoir project and provided that nothing in the legislation creating the wild and scenic segment shall affect or impair purposes of flood control, recreation, fish and wildlife, and hydropower (Williams, 1994).

However, if the U.S. Army Corps of Engineers moves forward with this proposal, the Water Rights Branch and national river management will request that the Office of the Solicitor assess the legal questions surrounding the potential conflict between the requirement for a "free-flowing" river under the Wild and Scenic Rivers Act (Kennedy, 1994), and the effects that would result from a change in lake elevation.

Another issue associated with Bluestone Dam is debris build-up. In the past, U.S. Army Corps of Engineers policy has been to pass all debris and drift through the dam in an episodic event following upstream flooding (U.S. Army Corps of Engineers, 1985a). In response to National Park Service and rafting industry concerns, the U.S. Army Corps of Engineers is experimenting with ways to separate the trash from the natural debris and pass the natural material through the penstocks while disposing the trash in a landfill.

The Bluestone Dam is coming up for relicensing soon, and there may be an opportunity to seek mitigation for effects on aquatic systems that result from this impoundment. However, only the Summersville Dam is licensed under the Federal Energy Regulatory Commission.

AGRICULTURAL AND URBAN RUNOFF

As shown in Figure 2, agricultural activities become increasingly prevalent in the upstream (southern) reaches of the Kanawha-New River basin. Nonpoint source pollution from row cropping, beef cattle pasturing, semi-confined dairy operations, and increasing numbers of poultry

are transported to New River Gorge National River from the Greenbrier, Bluestone, and upper sub-basins. The Bluestone and upper sub-basin contributions pass through Bluestone Lake before being discharged to the New River. Nutrient inputs from these basins feed eutrophication in Bluestone Lake (Pacific Northwest Environmental Research Laboratory and National Environmental Research Center, 1975). Subsequent releases of phytoplankton in the dam's tailwaters provide food for larval black flies in upper New River Gorge National River (Simmons et al., 1987; Voshell, 1984). The plan to increase Bluestone Lake levels for hydropower could aggravate eutrophication by increasing water retention time in the lake (U.S. Army Corps of Engineers, 1985b).

The Greenbrier River has not been routinely monitored as part of the New River Gorge National River water quality monitoring program. Additionally, nutrient data have been collected only on a sporadic basis in the three units. New River Gorge National River staff commented on the presence of algae and periphyton in the Bluestone River and are unable to answer public questions regarding the source of the algae or its potential relation to nutrient inputs. Pesticides and other bioaccumulants may also be transported to New River Gorge National River from row cropping in the upper basin. The NAWQA program, if funded in the basin, may provide further information regarding upper-watershed issues.

While the census data show population fluctuations, the general trend shows the larger population centers will continue to grow. No storm water retention measures are in place, and in most municipalities storm water and sewage are routed through the same systems. Urban runoff can be a source of heavy metals and other contaminants. Concentrations of several metals (mainly aluminum, iron, cadmium, and manganese) were found to be in excess of state standards by New River Gorge National River water quality monitoring. These exceedances occur most frequently in the tributaries, but some exceedances of less magnitude have occurred in the main stem (Wood, 1990).

COAL MINING, OIL AND GAS DEVELOPMENT

According to the general management plan for the New River Gorge National River (National Park Service, 1982), up to 7.1 million tons of recoverable surface coal are contained within the boundary of New River Gorge National River alone. Land acquisition did not include mineral rights and much of the land within the boundary remains in private ownership. No law or legislation guarantees these deposits will not be mined where they remain in private ownership. However, the New River Gorge National River Land Protection Plan (National Park Service, 1984) states that severe restrictions were placed on coal mining in Section 1105 of the National River's enabling legislation and by the 1977 Surface Mining Control and Reclamation Act. The latter designates units of the National Park Service unsuitable for surface coal mining operations.

As stated in the land protection plan, the shortage of economically recoverable coal reserves, poor market conditions, and the establishment of regulatory programs have contributed to a sharp decline in coal mining activity in and adjacent to the gorge. Most of the coal moving through the park is transported to the gorge for washing and/or handling or traveling the rail lines to market. There are two major non-operating coal processing plants and a deep mine within the boundary. Abandoned mine lands inventories identified 115 abandoned coal mines in New River Gorge National River alone. Most of these sites are unreclaimed (Armstrong and Yuill, 1991). There are 11 abandoned mine land sites within Gauley River National Recreation Area and eight active surface mines just outside the boundary. In addition, there are 20 active and five plugged and

abandoned gas wells in Gauley River National Recreation Area. New River tributaries with mine runoff problems are Piney, Wolf, Arbuckle, and Dunloup creeks. Peters Creek, a Gauley River tributary, is also affected by mine runoff.

Acid drainage is not a widespread problem because of the low sulfur content of the region's coal. However, Wolf Creek and a tributary to Meadow Creek have such concentrated discharges of acidic mine waters that low pH values are a problem. On Wolf Creek, fish kills due to low pH have caused the West Virginia Department of Natural Resources to discontinue trout stocking in this tributary (Hesse and Hambrick, 1991; Conway, 1993). The Meadow Creek tributary runs directly through a 400 feet thick deposit of mine waste and sodium hydroxide is dumped into this stream to neutralize excessive acid. In several other tributaries, metal-laden waters and sediment from barren, unreclaimed mine spoils result in reduced habitat quality. Mine-land runoff and metals contamination do not significantly affect the New River because of dilution.

Other issues associated with mineral operations include potential PCB (polychlorinated biphenyl) contamination from abandoned electrical transformers left at mine sites, runoff from improperly constructed access roads, reclamation of abandoned mines and roads, and leachate from mine refuse piles entering streams and/or ground water. Continued mining and passage construction could result in more changes to groundwater transport systems affecting springs, seeps, and associated wetlands. Mining-related sites have been mapped and inventoried but the information is not in digital format.

SILVICULTURAL ACTIVITIES

The headwaters of the Gauley and Greenbrier rivers drain from the Monongahela National Forest, while the New River dissects the Jefferson National Forest south of the West Virginia/Virginia state line. These forested watershed areas are well managed with regard to their water quality and quantity contributions to New River Gorge National River and Gauley River National Recreation Area. Of the forest lands outside U.S. Forest Service boundaries, ongoing logging is mostly small scale and removes predominantly larger trees (Gaber, 1989). Several 1,000+ acre tracts of land owned by timber companies lie within the middle sub-basin and the New River Gorge National River boundary (National Park Service, 1982), and the likelihood of a large-scale harvest recently increased with the construction of an oriented strand board plant in the drainage of Dunloup Creek.

This Georgia Pacific oriented strand board plant is scheduled to come on-line in July, 1995. The plant will demand an available supply of timber and the chipping process will allow cutting of relatively small trees. Large scale timber operations could result in sedimentation of streams given the nature of the soils and the steep topography. Also, effluent from the Georgia Pacific plant will be routed through the Mt. Hope sewage treatment plant and add additional pollutants to Dunloup Creek. According to a review conducted by the National Park Service's Water Resources Division (Rosenlieb, 1993), 29 constituents in the process waters will be delivered to Mt. Hope. Nine of these constituents (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, and phenols) are listed as toxic substances in section 307 of the Clean Water Act. The potential for dioxin contamination, often associated with wood and paper processing facilities, is not known at this time. New River Gorge National River has no sufficiently analyzed water quality, fish, or sediment from Dunloup Creek to provide a complete baseline for future, post-discharge comparisons.

WATER QUALITY AND DATA MANAGEMENT

Kunkle et al. (1983) reviewed the water quality monitoring program at New River Gorge National River and presented suggestions to improve its cost effectiveness and quality. Their review of the data showed the water quality of the New River main stem to be fair to good; however, some of the tributaries appeared to be more polluted. At the time of the study, there were only three tributaries monitored (Arbuckle, Dunloup, and Piney) and the data showed them to be "very impacted by sewage." Based on the recommendations of Kunkle et al. (1983), and comments and assistance from the U.S. Geological Survey and West Virginia Department of Natural Resources, New River Gorge National River began reporting water quality data in 1985.

New River Gorge National River continues to develop a comprehensive water quality monitoring program. Sampling stations are located on 11 tributaries and seven river corridor sites at New River Gorge National River, and three river locations and two tributaries at both Bluestone National Scenic River and Gauley River National Recreation Area. Parameters analyzed include dissolved oxygen, conductivity, pH, temperature, turbidity and discharge (provided through U.S. Geological Survey rating curves on eight tributaries and one gauging station on the river) and are collected approximately twice monthly from May through October. Alkalinity, aluminum, manganese, and iron are sampled quarterly. Park staff also conduct bacteria monitoring at key sites during the recreation season to elucidate potential health hazards associated with pathogens in the water. Recently, the park installed a continuous water quality monitoring probe near the U.S. Geological Survey gauging station at Thurmond to measure dissolved oxygen, conductivity, temperature, and pH. In 1987 the park contracted with the Virginia Polytechnic Institute and State University to develop a long-term ecological monitoring system (LTEMs) to assess impacts from the black fly spraying program. The park resource management staff has administered the LTEMs program since 1992.

One facet of the LTEMs that particularly compliments water quality monitoring is a bioassessment component to assess the health of macroinvertebrate communities. New River Gorge National River is currently expanding biological protocols to monitored tributaries. A draft report completed in-house discussed the findings of recent biological monitoring (National Park Service, 1994b). Rapid bioassessment protocols were used to collect aquatic macroinvertebrates and rank tributaries based on percent intolerant taxa, diversity, community structure and composition, and other metrics. The results were in general agreement with physicochemical data and showed major shifts toward tolerant organisms where pollution loads were high. Relatively clean streams were shown to have almost three times as many macroinvertebrate families represented as impacted tributaries.

A significant amount of data has been collected since the water quality monitoring program was established in the 1980s and more data are being collected each year. Unresolved issues associated with the program involve data collection and management. The development of a water quality monitoring plan that discusses why parameters were selected for analysis, how stations and sampling frequencies were selected, what additional data should be collected, and what methodology should be followed in data collection, storage, and interpretation, could address data management concerns.

TROUT STOCKING IN TRIBUTARIES

The enabling legislation for all three units allows fish stocking by the state of West Virginia within park boundaries in consultation with park management. Introducing exotic species upsets the balance of natural communities and runs contrary to fundamental National Park Service management practices. It also changes the nature of the fishing experience and leads to a put-andtake fishing mentality. Streams are stocked with rainbow, brown, and brook trout and include Wolf Creek (temporarily withdrawn due to poor water quality), both Glade Creeks, Pinch Creek, Dunloup Creek, and Meadow Creek (see Figure 3). The New River is not directly stocked, but trout do migrate in from tributaries. In New River Gorge National River tributaries, trout do not survive the fishing pressure, poor water quality, and warm summer temperatures, and are replaced each spring. The Gauley River is also stocked with the same three species of trout. At Gauley River National Recreation Area, the coldwater releases from the Summersville Dam keep salmonid populations alive throughout the year.

ABANDONED LANDFILL, SUPERFUND SITE, AND MILITARY DUMP

At the head of Rush Run drainage on the New River lies the abandoned Fayette County landfill. Leachate from this site may be leaking into ground and/or surface waters and transporting toxic compounds to this stream. Collection basins are installed around the facility to trap surface runoff, but overflow on a regular basis. Monitoring data from ground and surface water associated with this site is available from the West Virginia Division of Environmental Protection. Closing this landfill has resulted in trash being hauled out of the county which requires increased tipping fees. Increased tipping fees spawn more road-ditch and drainage dumping. The lighter trash from these scattered dumps moves down-slope to tributary drainages. One reach on Dunloup Creek is referred to as "styrofoam falls" as a tribute to this phenomenon.

An abandoned transformer and capacitor rebuilding facility is located on Arbuckle Creek. Over 4,700 tons of PCB-contaminated soil was removed in 1987 under direction of the U.S. Environmental Protection Agency. Additional testing revealed remnant contamination from this facility. In 1990 and 1991, over 500 cubic yards of soil were removed. It is not known whether PCBs found their way to Arbuckle Creek or if this compound is present in bed sediment or fish tissue samples taken from this tributary.

Park staff have also reported effluent leaking from a closed military training site located within park boundaries. The U.S. Army Corps of Engineers used this site to train engineers to build and destroy floating bridges. Samples were collected from a small surface seep with unknown origins, but were not analyzed despite their colorations. The facility reportedly used an unlined grease pit when servicing vehicles. Just before the facility closed, residents reported that a semi-truck dumped barrels with unknown contents into this pit and covered them. New River Gorge National River has received funding to conduct a restricted phase II environmental site assessment for this location.

HAZARDOUS MATERIALS/TOXICS

In addition to the municipal and industrial discharges, coal mine operations, abandoned landfill, superfund site, and military dump, highway arteries and railway lines add another dimension to the

potential impacts from hazardous and toxic materials. A major rail line runs the length of New River Gorge National River leading from Charleston to markets farther south and east. Two major highways and four smaller roads also cross the national river, and the approaches to the river are typically steep and curvy. If a derailment or tanker-truck accident were to occur and spill environmentally damaging materials, the New River would be the receiving conduit. Approximately four derailments have occurred in the past 10 years, most spilling coal; however, one accident involved sulfated mercury. Smaller spills have also been documented by park employees. In addition, rail lines are typically within 150 feet of the New River and herbicide sprayed within the riparian corridor can migrate into the river if the application is followed by a summer thunderstorm.

A recent spill (unknown contaminant) on the upper Bluestone River resulted in the loss of tens of thousands of fish. In an effort to prepare for such a disaster at New River Gorge National River, the National Park Service has cooperated with the U.S. Geological Survey to conduct travel time studies simulating the movement and dispersion of soluble and insoluble contaminants (Appel and Moles, 1987). Models were employed to determine how and when releases from upstream impoundments could be used to dilute a spilled chemical or speed its passage through sensitive park waters (Wiley, 1992;1993).

BLACK FLY SPRAYING

In the 1980s, the state of West Virginia conducted a spraying program to reduce the number of black flies emerging from the New River below Bluestone Dam. Black flies occur naturally in this reach of the river, but their production is boosted by elevated seston concentrations passing through the Bluestone Dam (Virginia Polytechnic Institute and State University, 1985; Armine, 1982;Hopkin, 1976). Spraying was conducted using the bacterial pesticide Bti (*Bacillus thuringiensis isaelensis*) that kills the aquatic black fly larvae. The National Park Service protested the spraying because no documented public health risk is posed by the nuisance black flies, and no data were available to determine the impacts to non-target species and the ecology of the river. A court injunction was requested by the National Park Service and subsequently granted. The court determined the National Park Service has jurisdiction over the New River and the wildlife contained therein (including black flies), and ordered the spraying program halted.

To circumvent the court ruling, Congress passed legislation on July 11, 1987, allowing the West Virginia Department of Natural Resources to conduct an eight-year pesticide spraying program on the New River to control the black fly population. Also included in this legislation was a mandate for the National Park Service to design and implement a LTEMs to address the effects of the pesticide on the natural, cultural, and recreational values of the national river. This legislation expired in July, 1995, and the state and National Park Service are to begin consultation to determine how the program will proceed based on the results of monitoring. At this time, New River Gorge National River has not received a final report from Virginia Polytechnic Institute and State University discussing the ecological implications of the spraying program. The LTEMs collects data on benthic macroinvertebrates, fish, algae, and numerous water quality parameters from five river sites once per year.

FUTURE DEVELOPMENT

As discussed previously under the "Land Use" section, human population levels fluctuate significantly within the middle sub-basin (590 mi², 9% of basin). New River Gorge National River employees who have lived near the park for many years tell of increasing populations in nearby urban areas and this appears to be substantiated by the overloaded sewage plants. As in much of the United States, land use planning is virtually nonexistent in southern West Virginia. Almost one third of the land within New River Gorge National River boundaries remains in private ownership. National Park Service authority on these lands is limited and uncontrolled growth could increase pollution loads in the river and tributaries. Unfortunately, land use studies have not been conducted for the areas surrounding New River Gorge National River other than the U.S. Geological Survey work conducted on a large scale and presented in Figure 2. Detailed land use data, if available, could be correlated with water quality monitoring results to identify and prioritize pollution sources.

A proposed water withdrawal from the New River near Hawk's Nest Dam would provide a more dependable source of drinking water for the surrounding Plateaus Region. While the withdrawal would take place downstream from the park boundaries and not directly impact water flow in the New River, it would increase the potential for development. Increased development means increased water usage that equates to increased inputs to the sewage treatment plants at Fayetteville, Oak Hill, and Lansing, all of which discharge to tributaries of the New River. Development already planned includes: 1) a resort complex (still to be defined) adjacent to New River Gorge National River's north boundary on the west side of the river; 2) the federal penitentiary that will soon be added to the already overloaded Beckley sewage system (without any requirement for pre-treatment), thereby potentially increasing sewage loads to Piney Creek and the New River; and 3) drilling operations on gas reserves near Gauley River National Recreation Area, and the potential effects these operations may have on park waters -- eight new gas wells have been developed inside Gauley River National Recreation Area since March, 1995.

The West Virginia's Departments of Natural Resources and Environmental Protection recently released a draft *Strategic Plan for West Virginia's Watersheds* that attempts to lay the ground work for addressing most of the issues covered in this document (West Virginia Department of Natural Resources and Department of Environmental Protection, 1995). The watershed program is titled the West Virginia Watershed Conservation and Management Program and addresses such issues as water quality and quantity, information management, land use planning, private property, sustainable economic development, access, fish and wildlife management, wetlands, and education. The plan also includes strategies for implementing the goals of the program. Additionally, a number of private conservation groups, such as the Greenbrier Watershed Coalition, have formed with the goal of preserving West Virginia's streams.

RECOMMENDATIONS

The complex array of water resource issues necessitates further planning. Increasing visitation to these park units must be considered. The complex nature of surface water (i.e., impoundments dampening natural flow variations) and groundwater (karst-like development from mining) will affect planning. The potential for future development inside and beyond park boundaries, and the complexity of landownership and/or jurisdictional responsibility will figure into future considerations. The nature of certain issues, including fish contaminant warnings, the number of abandoned coal mines, and the pervasiveness of bacterial contamination from human sewage, in relation to the number of water-based recreational activities will call for a delicate balance. These issues clearly warrant the development of a comprehensive water resources management plan.

An important element of this water resources management plan should be the development of a water quality monitoring plan. This monitoring plan should provide details of the rationale behind the selection of monitoring parameters, sampling stations and sampling frequencies, additional data collection, and methodologies for data collection, storage, and analysis. Adequate quality assurance and quality control procedures should be included. The development of a water quality monitoring plan would benefit greatly from a comprehensive analysis of existing water quality data to determine statistical significance, conduct trend analysis, and provide meaningful interpretations for management. This analysis should attempt to define the relationship(s) of various land use activities to water quality parameters (i.e., physical, chemical, and biological). To accomplish this, a more efficient means of storing and manipulating park data is needed. The park is encouraged to institute more efficient data storage techniques and develop a preliminary water quality monitoring plan as interim water resource projects until funding and priorities coincide for development of the water resources management plan.

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As the nation's principal conservation agency, the Department of the Interior has the responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.